

TR14-197-201

R.596. Production of fly ash from coal slurry

The aim of the investigation was to produce from coal slurry, a waste product from the Cornwall Coal Company's washery, a product conforming to the Hydro-Electric Commission's specification for fly ash for concrete.

The use of this product in the production of porous ceramic tubes is the subject of report R.573 (p. 212).

The Company proposed burning the slurry to produce the required fly ash. Because this slurry had a high ash content the yield of suitable fly ash could be high.

SPECIFICATION FOR FLY ASH

The Hydro-Electric Commission specification S2384 covers:

- (1) Chemical composition;
- (2) Sizing.

In addition, a spherical grain is preferred to an angular grain.

SAMPLES

Two samples were used for the tests. The original small sample is referred to as R.596. Later a large drum of similar material was received. This was given the register number 691816.

PROCEDURE

- (1) Ash was made from the coal slurry by heating in a muffle furnace to 900° C in all tests.
- (2) Sizings were made, using sieves and the cyclosizer on the following:
 - (a) the coal slurry as received;
 - (b) the ash made by burning this coal slurry (a);
 - (c) the ground ash produced after dry grinding in a ball mill for twelve minutes the ash made in (b);
 - (d) the ground slurry produced by dry grinding in a ball mill for ten minutes, the coal slurry as received (a); and
 - (e) the ash made by burning this ground slurry (d).
- (3) Ash made as in paragraph (1) was mixed with varying amounts of lime or powdered hematite then pressed into cones which were heated to 900° C to see if any fusion occurred.
- (4) The ash from both samples was analysed.
- (5) Flotation tests to reduce the ash content were done on the slurry when it was found that the ash content of 691816 was too high for use in making porous tubes.

RESULTS

(1) *Sizing results*

Sizing results from sample R.596 are given in Table 1.

NOTE (1) Cyclosizer overflows (O/F) by difference.

(2) The mean particle sizes for the cyclosizer fractions have been obtained using 1.6 as the S.G. of the slurry and 2.7 for the ash. The particle sizes are:

Fraction	Slurry μ	Ash μ
C.S. 1	67	44
2	50	36
3	36	26
4	24	16
5	16	12

To conform with the Hydro-Electric Commission specification on grain size:

- (1) The mean particle diameter must not exceed 9.0μ;
- (2) the amount retained when wet sieved on a 44μ sieve must not exceed 12%.

(2) *Fusion test*

Results from cones fired at 900° C:

Mixture	Result
a. 5% lime	} No sign of fusion in any test.
b. 10% lime	
c. 5% hematite	
d. 10% hematite plus 1% fine coal	

(3) *Chemical analysis*

Item No.	Description	Sample R.596 %	Sample from 691816 %	H.E.C. specification %
Slurry analysis—				
1.	moisture	15	—	—
2.	ash	27.9	37.2	—
Ash analysis—				
3.	SiO ₂	53.7	54.1	
4.	Fe ₂ O ₃	4.7	5.4	
5.	Al ₂ O ₃	29.7	29.8	
6.	3 + 4 + 5	88.1	89.3	70.0
7.	MgO	0.86	0.86	5.0
8.	Na ₂ O	—	0.3	
9.	K ₂ O	—	0.7	
10.	8 + 9	—	1.0	1.5
11.	SO ₂	3.2	—	4.0
12.	CaO	—	6.3	

A grab sample was taken from the drum of slurry 691816 for ceramic tests and analysis. In view of the calculated ash contents obtained in the flotation tests the contents of the drum must have been segregated with respect to ash content.

(4) *Flotation tests*

(a) Flotation conditions:

Test No.	Material	Collector	Frother
N1	R.596 slurry as received	kerosene	creylic acid
N2	R.596 slurry as received	kerosene	creylic acid
N3	69186 slurry as received	kerosene	creylic acid
N4	691816 - 36 mesh slurry	kerosene	Teric 401

(b) Flotation results:

Test No.	Fraction	% Weight	% Ash	Ash distribution %
N1	F/C	41.4	19.8	29.1
	F/T	58.6	34.0	79.9
	Head	100.0	(28.1)	100.0
N2	F/C	77.6	30.3	70.9
	F/T	22.4	43.1	29.1
	Head	100.0	(33.2)	100.0
N3	C F/C	83.1	19.9	67.9
	C F/T	5.2	57.8	12.3
	R F/C	88.3	(22.1)	80.2
	R F/T	11.7	41.2	19.8
	Head	100.0	(24.4)	100.0
N4	+ 36 mesh	7.4	19.3	6.0
	C F/C	78.3	18.0	59.4
	C F/T	6.1	63.9	16.4
	R F/C	84.4	(21.3)	75.8
	R F/T	8.2	52.7	18.2
	Head	100.0	(23.7)	100.0

NOTE: (1) Some of the fine coal concentrate of N2 F/C ignited while drying under lights.

(2) All flotation tests were very easily performed and stage addition of reagents practised.

TABLE 1. SIZINGS FROM SAMPLE R.596

Fraction Aperture μ	<i>a</i> Coal slurry		<i>b</i> Ash from <i>a</i>		<i>c</i> Ground ash <i>b</i>		<i>d</i> Ground slurry		<i>e</i> Ash from <i>d</i>	
	Wt %	Cum. wt %	Wt %	Cum. wt %	Wt %	Cum. wt %	Wt %	Cum. wt %	Wt %	Cum. wt %
+ 600	1.7	1.7	1.9	1.9	—	—	—	—	0.1	0.1
+ 300	12.2	13.9	2.1	4.0	0.4	0.4	—	—	0.3	0.4
+ 150	14.4	28.3	9.3	13.3	5.5	5.9	2.9	2.9	0.8	1.2
+ 105	7.1	35.4	10.5	23.8	3.3	9.2	8.2	11.1	1.6	2.8
+ 75	6.3	41.7	12.3	36.1	4.1	13.3	11.3	22.4	4.5	7.3
C.S. 1	7.3	49.0	3.4	39.5	3.0	16.3	0.9	23.3	2.9	10.2
C.S. 2	8.5	57.5	5.8	45.3	9.9	26.2	2.1	25.4	6.7	16.9
C.S. 3	7.8	65.3	8.6	53.9	12.2	38.4	7.6	33.0	9.3	26.2
C.S. 4	7.5	72.8	8.7	62.6	12.9	51.3	13.5	46.5	9.7	35.9
C.S. 5	3.6	76.4	4.6	67.2	7.4	58.7	5.4	51.9	5.4	41.3
O/F	23.6	100.0	32.8	100.0	41.3	100.0	48.1	100.0	58.7	100.0

DISCUSSION

- (1) Sizing analyses of the ash show:
 - (a) Ash from 'as received' slurry (b) is 39.5% + 44 μ and is therefore too coarse;
 - (b) This same ash after ball mill grinding (c) is 16.3% + 44 μ hence it is still too coarse;
 - (c) Ash made from ground slurry (e) with 10.2% + 44 μ meets the specification requirement.
- (2) Therefore either the slurry must be ball milled before burning to obtain a complete yield of satisfactorily sized ash or the ash produced by burning the slurry must be sized. In this case about one-third of the ash made would be discarded as oversize. Neither approach appears to be economically sound.
- (3) Attempts to lower the fusion point of the ash and hence convert the angular ash to spherical grains using either lime or iron oxide were unsuccessful
- (4) The ash conforms chemically to the specification.
- (5) Flotation tests show a product containing less than 20% of ash can be made from the slurry. Further work on porous tube production is reported in R.573. (p. 212).

CONCLUSION

While the fly ash conforms chemically to requirements, sizing conformation would not be obtained without quite expensive treatment which would probably not be economically justifiable.